

an alcohol and at least two inorganic acids, wherein a major component of said composition is non-aqueous.

86. A composition for selectively etching gallium arsenide, said composition consisting essentially of:

an alcohol and at least two inorganic acids, wherein a major component of said composition is non-aqueous.

### REMARKS

Claims 1-81 are pending in this application. Claims 8, 12, 19-21 have been deleted. Claim 1 has been amended. Claims 82-86 have been newly added.

Claims 1-4, 6, 9 and 10 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Mitsubishi Electric Corp. (JP 0048816). The rejection is respectfully traversed.

The claimed invention is a non-aqueous etching mixture which consists essentially of an alcohol in combination with at least two inorganic acids. As such, amended independent claim 1 recites a composition for "selectively etching a doped substance" comprising "an alcohol and at least two inorganic acids, wherein a major component of said composition is non-aqueous." Dependent claim 4 further recites that the alcohol could be ethylene glycol or propylene glycol, while dependent claim 6 recites a "C<sub>2</sub>-C<sub>6</sub> alcohol." Similarly, dependent claim 9 recites "hydrofluoric acid, nitric acid,

phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid” as choices for inorganic acids.

Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) does not disclose the limitations of the claimed invention. Mitsubishi discloses an aqueous etchant for silicon, which includes an acid with viscosity higher than that of water, such as phosphoric acid, or an anionized organic compound with viscosity higher than that of water, such as ethylene glycol or glycerol, in addition to hydrogen fluoride (HF) and nitric acid (HNO<sub>3</sub>) (Abstract). According to Mitsubishi, the addition of phosphoric acid, which has a much higher viscosity than that of water, to the aqueous etching solution increases the viscosity of the etching liquid, which in turn is prevented from entering narrow gaps in a silicon semiconductor device (Abstract). Mitsubishi does not disclose, therefore, a composition for selectively etching a doped substance which consists essentially of an alcohol and at least two inorganic acids, “wherein a major component of said composition is non-aqueous,” as amended independent claim 1 recites, or the use of any other inorganic acids, such as sulfuric acid or carbonic acid, as dependent claim 9 recites. Accordingly, the limitations of the present invention are not described in Mitsubishi and, thus, the present invention is not anticipated under § 102(b).

Claims 5, 11 and 12 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 1. The rejection is respectfully traversed.

The claimed invention teaches a non-aqueous etching mixture which consists essentially of an alcohol in combination with two inorganic acids. As such, dependent claim 5 recites that the alcohol is propylene glycol. Further, claim 11, rewritten as independent claim 83, recites a composition for etching doped substances including “propylene glycol and at least two inorganic acids.” Claim 12, rewritten as dependent claim 84, further recites that the composition is “a non-aqueous composition.”

Mitsubishi teaches an aqueous etchant for silicon, which comprises an acid with viscosity higher than that of water, such as phosphoric acid, or an anionized organic compound with viscosity higher than that of water, such as ethylene glycol or glycerol, in addition to hydrogen fluoride (HF) and nitric acid (HNO<sub>3</sub>) (Abstract). According to Mitsubishi, the addition of phosphoric acid, which has a higher viscosity than that of water, to the aqueous etching solution increases the viscosity of the etching liquid, which in turn is prevented from entering narrow gaps in a silicon semiconductor device (Abstract). Mitsubishi is silent as to the use of “propylene glycol and at least two inorganic acids,” as independent claim 83 recites, or to “a non-aqueous composition,” as dependent claim 84 recites. The Office Action, however, concludes that “it would have been obvious . . . [to] replac[e] ethylene glycol with propylene glycol because both solvents are . . . homologous . . . and substituting one for (sic) would produce the best result.” (Office Action at 3).

The claimed invention is not obvious over Mitsubishi. First, Mitsubishi expressly recites an aqueous solution, while claim 84 of the invention recites a non-aqueous composition. Second, substituting ethylene glycol with propylene glycol would be of little importance in the present case since the claimed invention recites a non-aqueous

composition while, in contrast, Mitsubishi teaches an aqueous solution. Thus, there is no teaching in Mitsubishi for the claimed subject matter.

Claims 7 and 8 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 1. The rejection is respectfully traversed.

Dependent claim 7 recites a C<sub>2</sub>-C<sub>6</sub> alcohol selected from the group consisting of ethanol, propanol, isopropanol, iso-butanol, and n-butanol for a composition the major component of which is non-aqueous. Independent claim 82, rewriting claim 8, further recites “isopropanol and at least two inorganic acids, wherein a major component of said composition is non-aqueous,” as part of an etching composition.

The claimed invention is not obvious over Mitsubishi. Mitsubishi expressly recites an aqueous solution, while claim 82 of the invention recites a non-aqueous composition. Further, “replacing ethylene glycol with a conventional alcohol selected from the group consisting of ethanol, propanol, isopropanol, isobutanol, and n-butanol” would not produce the claimed invention, as the Office Action asserts, (Office Action at 3), mainly because the viscosity of the enumerated alcohols varies greatly. For example, 1-propanol has a viscosity of 1.945 mPa s at 25°C, while n-propanol has a viscosity of 2.038 mPa s at 25°C. In contrast, glycerol has a much higher viscosity, of 934 mPa s at 25°C, explained mainly by the addition of the hydroxyl groups. Thus, a person of ordinary skill in the art would not have been motivated to substitute isopropanol, a form of propanol, with glycerol

because isopropanol does not satisfy the viscosity requirement of Mitsubishi, and withdrawal of this rejection is respectfully requested.

Claims 13-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) ("Mitsubishi") as applied to claim 1. The rejection is respectfully traversed.

The claimed invention teaches a non-aqueous etching mixture which consists essentially of an alcohol, such as a polyhydric alcohol, in combination with at least two inorganic acids. As such, dependent claim 13 recites that the ratio of alcohol to a first acid to a second acid is of about 10-50:5-40:1, while dependent claim 15 further limits such ratio to about 30:20:1. Similarly, dependent claim 16 recites a ratio of propylene glycol to nitric acid to hydrofluoric acid of about 10-50:5-40:1, while dependent claims 17 and 18 further limit such ratio to about 20-40:10-30:1 and 30:20:1, respectively.

The claimed invention is not obvious over Mitsubishi. First, Mitsubishi is silent about any ratio of hydrogen fluoride to nitric acid. Second, the crux of Mitsubishi is raising the viscosity of the aqueous etching solution, by adding, for example, phosphoric acid instead of half of the nitric acid. For this, Mitsubishi teaches, for example, a mixed liquid of 50% HF solution with HNO<sub>3</sub> 20 parts by volume and H<sub>3</sub>PO<sub>4</sub> 20 parts by volume, which improves the viscosity of the etching solution. Thus, Mitsubishi is not concerned with the ratio of the two inorganic acids, but rather with the addition of an organic or inorganic compound that would replace any of the two inorganic acids and that would increase the viscosity of the etching solution.

Claims 19-21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 1. The rejection is respectfully traversed.

The claimed invention relates to etching a doped substance with a non-aqueous etching mixture which consists essentially of an alcohol in combination with at least two inorganic acids. As such, independent claim 84 (rewritten as claim 19) recites etching of “a doped amorphous, doped pseudo-crystalline or doped polycrystalline silicon” with an alcohol and at least two inorganic acids, so that a major component of the etching composition is non-aqueous. Further, independent claims 85 (rewritten as claim 20) and 86 (rewritten as claim 21) recite etching of doped germanium and of gallium arsenide, respectively.

Mitsubishi relates only to the etching of silicon and only with an aqueous solution with a high viscosity coefficient. Mitsubishi is silent about any doped substance or substrate. Further, Mitsubishi does not teach the use of a non-aqueous solution, but rather the use of an aqueous solution with either an organic or inorganic substance which has high viscosity. Accordingly, there is no teaching or suggestion in Mitsubishi for the claimed subject matter and withdrawal of this rejection is respectfully requested.

Claims 22-24, 27, 30 and 31 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Mitsubishi Electric Corp. (JP 0048816). The rejection is respectfully traversed.

The claimed invention teaches a non-aqueous etching mixture which consists essentially of an alcohol in combination with at least two inorganic acids. As such, independent claim 22 recites a “a non-aqueous composition of an alcohol and at least two inorganic acids” for “selectively etching doped silicon.” Dependent claim 24 further recites that the alcohol could consist of ethylene glycol, propylene glycol, butylene glycol, dipropylene glycol, sorbitol, hexylene glycol, 1,3-dibutylene glycol, 1,2,6-hexanetriol and 1,5-pentanediol.” Similarly, dependent claim 27 recites that the alcohol could be a  $C_2$ - $C_6$  alcohol. Claim 30 further defines the inorganic acids as “hydrofluoric acid, nitric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid,” while claim 31 recites the use of both nitric acid and hydrofluoric acid.

Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) does not disclose the limitations of the claimed invention. Mitsubishi discloses an aqueous etchant for silicon, which includes an acid with viscosity higher than that of water, such as phosphoric acid, or an anionized organic compound with viscosity higher than that of water, such as ethylene glycol or glycerol, in addition to hydrogen fluoride (HF) and nitric acid ( $HNO_3$ ) (Abstract). According to Mitsubishi, the addition of phosphoric acid, which has a much higher viscosity than that of water, to the aqueous etching solution increases the viscosity of the etching liquid, which in turn is prevented from entering narrow gaps in a silicon semiconductor device (Abstract). Mitsubishi does not disclose, therefore, “a composition for selectively etching doped silicon” or “a non-aqueous composition,” as independent claim 22 recites. Accordingly, the limitations of the present invention are not described in Mitsubishi and, thus, the present invention is not anticipated under § 102(b).

Claims 26 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 22. The rejection is respectfully traversed.

The claimed invention recites a non-aqueous composition for etching doped silicon which consists essentially of an alcohol in combination with at least two inorganic acids. As such, dependent claims 26 and 32 recite that the alcohol is propylene glycol.

Mitsubishi teaches an aqueous etchant for silicon, which comprises an acid with viscosity higher than that of water, such as phosphoric acid, or an anionized organic compound with viscosity higher than that of water, such as ethylene glycol or glycerol, in addition to hydrogen fluoride (HF) and nitric acid (HNO<sub>3</sub>) (Abstract). Mitsubishi is silent as to the use of “propylene glycol and at least two inorganic acids,” as independent claims 26 and 32 recite, to “a non-aqueous composition,” as independent claim 22 recites, for etching of doped silicon.

Claims 28 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 22. The rejection is respectfully traversed.

Dependent claim 28 recites a C<sub>2</sub>-C<sub>6</sub> alcohol selected from the group consisting of ethanol, propanol, isopropanol, iso-butanol, and n-butanol for a composition the major component of which is non-aqueous. Dependent claim 29 further recites “isopropanol” as part of the etching composition.



Again, the claimed invention is not obvious over Mitsubishi. First, Mitsubishi expressly recites an aqueous solution, while claims 28 and 29 recite alcohols in the context of a non-aqueous composition. Second, “replacing ethylene glycol with a conventional alcohol selected from the group consisting of ethanol, propanol, isopropanol, isobutanol, and n-butanol” would not produce “the best result,” as the Office Action asserts, (Office Action at 6), because the viscosity of the enumerated alcohols varies greatly. For example, 1-propanol has a viscosity of 1.945 mPa s at 25°C while n-propanol has a viscosity of 2.038 mPa s at 25°C. Further, ethanol has a viscosity of 1.074 mPa s at 25°C, which decreases considerably when increasing the temperature (0.694 mPa s at 50°C). In contrast, glycerol has a viscosity of 934 mPa s at 25°C, explained mainly by the addition of the hydroxyl groups and the decrease in the distance between any adjacent hydroxyl groups. Thus, a person of ordinary skills in the art would not have been motivated to substitute isopropanol, a form of propanol, with glycerol because isopropanol does not satisfy the viscosity requirements of Mitsubishi, and withdrawal of this rejection is respectfully requested.

Claims 33-38 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”) as applied to claim 22. The rejection is respectfully traversed.

The claimed invention recites a non-aqueous etching composition which consists essentially of an alcohol in combination with at least two inorganic acids. As such, dependent claim 33 recites that the ratio of alcohol to a first acid to a second acid is of about 10-50:5-40:1, while dependent claim 35 further limits such ratio to about 30:20:1.

Similarly, dependent claim 36 recites a ratio of propylene glycol to nitric acid to hydrofluoric acid of about 10-50:5-40:1, while dependent claims 37 and 38 further limit such ratio to about 20-40:10-30:1 and 30:20:1, respectively.

The claimed invention is not obvious over Mitsubishi. First, Mitsubishi is silent about any ratio of hydrogen fluoride to nitric acid. Second, the crux of Mitsubishi is raising the viscosity of the aqueous etching solution, by adding, for example, phosphoric acid instead of half of the nitric acid. For this, Mitsubishi teaches, for example, a mixed liquid of 50% HF solution with  $\text{HNO}_3$  20 parts by volume and  $\text{H}_3\text{PO}_4$  20 parts by volume, which improved the viscosity of the etching solution. Thus, Mitsubishi does not contemplate the ratio of the two inorganic acids, but rather the addition of an organic or inorganic compound that would increase the viscosity of the etching solution. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 39-41 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) (“Mitsubishi”). The rejection is respectfully traversed.

The claimed invention recites a non-aqueous etching composition which consists essentially of an alcohol in combination with at least two inorganic acids. As such, independent claim 39 recites “a non-aqueous composition comprising propylene glycol, nitric acid and hydrofluoric acid” in a ratio of 10-50:5-40:1 for selectively etching doped polysilicon to undoped polysilicon. The ratio of propylene glycol to nitric acid to


hydrofluoric acid is further defined in claims 40 and 41 as of about 20-40:10-30:1 and 30:20:1, respectively.

The claimed invention is not obvious over Mitsubishi. Mitsubishi is silent about any ratio of hydrogen fluoride to nitric acid or any ratio of propylene glycol to nitric acid to hydrofluoric acid. In addition, Mitsubishi is silent about using propylene glycol, or using propylene glycol at 35°C, on doped and undoped polysilicon. Further, the crux of Mitsubishi is raising the viscosity of the aqueous etching solution, by adding, for example, phosphoric acid instead of half of the nitric acid. For this, Mitsubishi teaches, for example, a mixed liquid of 50% HF solution with HNO<sub>3</sub> 20 parts by volume and H<sub>3</sub>PO<sub>4</sub> 20 parts by volume, which improved the viscosity of the etching solution. Thus, Mitsubishi does not address the ratio of the two inorganic acids or the ratio of the alcohol and the two inorganic acids, but rather the addition of an organic or inorganic compound that would increase the viscosity of the etching solution. Accordingly, withdrawal of this rejection is respectfully requested.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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